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60,130-1907; 03MRA0279

**UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Hayes  
Serial No.: 10/765,291  
Filed: 1/27/2004  
Art Unit: 3617  
Title: Central Tire Inflation System for Drive Axle

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

**PRELIMINARY AMENDMENT**

Dear Sir:

Please preliminarily amend the subject application as follows:

*Exhibit A*



60,130-1907; 03MRA0279

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### IN THE SPECIFICATION

Please make the following changes to the referenced Specification paragraphs:

[3] CTI systems include an air tank that is mounted on the vehicle. Air is supplied from the tank to the tires by using various methods. CTI systems can be incorporated into drive or non-drive axles. Traditionally, for either type of axle, CTI systems include an air connection that allows air to be supplied from a non-rotating air source to ~~the~~ rotating tires. Some systems include an air connection that is mounted for rotation with a wheel hub assembly at one end, and which is mounted at an opposite end to a non-rotating axle tube for a non-drive axle. In these systems, air is supplied from the tank to an ~~the~~ interior of the axle tube. Air from inside the axle passes through the ~~rotating~~ air connection and is conducted to the rotating tires.

[4] Traditionally, CTI systems for drive axles have been more difficult to incorporate into conventional wheel ends. Typically, these CTI systems use drilled passageways in ~~the~~ rotating wheel hubs in combination with drilled passageways in ~~the~~ non-rotating spindles. This configuration requires large, expensive seals, is difficult to assemble, and is expensive to machine. Further, wheel hubs for drive axles using disc brakes and single tires often do not have enough packaging space to accommodate drilled passageways. Thus, using a CTI system for such a configuration is not practical.

[11] In one disclosed embodiment, the subject invention is incorporated into an inverted portal drive axle. The inverted portal drive axle includes an input driven by a vehicle power source and defining a longitudinal axis. The input is operably coupled to a differential, which is in driving

engagement with first and second axle shafts. In an inverted portal axle configuration, the input is positioned laterally closer to one wheel assembly than the other wheel assembly, thus, one of the first or second axle shafts is significantly longer than the other axle shaft. Each axle shaft drives a gear set that raises the driving input from a ~~the~~ lower axle shaft level up to a higher wheel axis level. The gear sets drive the wheel shafts, which in turn drive the wheel hubs. In this axle configuration, the bore is coaxial with the wheel axis of rotation, which is parallel to and spaced apart from an axle shaft axis of rotation. The fluid inlets at the inboard ends of the wheel shafts are easily accessed through a ~~the~~ non-rotating gearbox or axle housing. Thus, the air supply component can be easily installed to communicate with the wheel shaft bore without interfering with other wheel components and without requiring significant wheel modifications. A connector and hose assembly are operably coupled to each fluid outlet at the outboard end of the wheel shafts to conduct the air to the tire assemblies.

[14] Figure 1 is a schematic view of a drive axle assembly with a CTIS incorporating the subject invention.

[24] The CTI system 10 also includes a plurality of pressure valves and sensors that are used to monitor tire pressure, air supply pressure, and to control air flow throughout the CTI system 10. In one example shown in Figure 1, the CTI system 10 includes a pressure regulator and unloader valve assembly 16. The pressure regulator is typically set at a desired tire pressure level. The unloader valve is set at a lower pressure and prevents air from being supplied to a tire if there is a tire blowout. The unloader valve is normally open, however, if pressure output from

the pressure regulator falls below a certain pressure level, the valve closes to prevent depletion of the air supply in a tire blowout situation. Check valves 18 can be used in addition to the pressure regulator unloader valve assembly 16 to permit only one-way flow in the system. The CTI system 10 can also include hose pressure lines 20 that interconnect the air supply 14, pressure regulator and unloader valve assembly 16, and check valves 18 to the axle assembly 12. Optionally, or in addition to the components discussed above, pressure sensors 22 can be used at each tire assembly 24 to individually monitor tire pressure. It should be understood that these are just examples of certain types of valves, regulators, and sensors that could be used in the CTI system 10. Other CTI components known in the art could also be used in place of, or in addition to, the components discussed above.

[25] The inverted portal drive axle assembly 12 includes an input 26 that is operably coupled to a driving power source 28, such as an engine or electric motor. In one disclosed embodiment, the input 26 includes a pinion gear 30, which is driven by a driveshaft 32 coupled to the power source 28. The pinion gear 30 drives a ring gear 34, which is operably coupled to a differential gear assembly 36. First 38 and second 40 axle shafts are coupled to the differential gear assembly 36, which provides for axle shaft speed differentiation as the vehicle executes turning maneuvers. The first 38 and second 40 axle shafts drive first 42 and second 44 wheel gear assemblies, which in turn drive first 46 and second 48 wheel end assemblies.

[28] A perspective view of the inverted portal drive axle assembly 12 is shown in Figure 2. Each wheel end assembly 46, 48 defines a wheel axis of rotation 60 that is vertically higher

relative to ground level than the axle shaft axis of rotation 54. Thus, the driving input power or torque is transferred from the input 26, at a vertically lower position, up to drive the wheel end assembly 46, 48, at a vertically higher position. This transfer is achieved by the use of the first 42 and second 44 wheel gear assemblies.

[30] Each of the axle shafts 38, 40 drives one of the first 42 or second 44 wheel gear assemblies. The first 42 and second 44 wheel gear assemblies are preferably helical gear assemblies that each include a helical pinion gear or wheel input drive gear 74 driven by one of the axle shafts 38, 40, see Figure 4. The input drive pinion-gear 74 is in meshing engagement with a pair of helical idler gears 76, which in turn are in meshing engagement with a helical driven gear or wheel output driven gear 78. The gears 74, 76, and 78 are enclosed within a gear housing 80 that is supported by the axle housing 58. It should be understood that the helical gear assembly shown in Figure 4 is just one example of a wheel gear assembly, and that other wheel gear assemblies known in the art could also be used.

[31] The output driven gears 78 drive the wheel shafts 82 that are coupled to the wheel hubs 50. The wheel shafts 82 define the wheel axes of rotation 6058. The wheel gear assemblies 42, 44 raise the driving input from the vertically lower first 38 and second 40 axle shafts 38, 40 to the vertically higher wheel shafts 82. The wheel axes axes-of rotation 60 58-are parallel to and spaced apart from the axle shaft axes of rotation 54, and are transverse to the longitudinal axis of rotation 52. Thus, the input drive gears 74 are coaxial with the axle shaft axes of rotation 54, and the output driven gears 78 are coaxial with the wheel axes of rotation 6058.

[32] As shown in Figures 5A and 5B, the wheel shafts 82 each include a cylindrical shaft body 84 that has a first end face 86 and a second end face 88. A laterally extending bore 90 forms a fluid passage within the shaft body 84 that is in fluid communication with the air supply 14. The bore 90 is preferably coaxial with the wheel axis of rotation ~~60~~ 58 and extends through the entire length of the wheel shaft 82. The bore 90 has a fluid inlet 92 formed at the first end face 86, which is in fluid communication with the air supply 14. The bore 90 has a fluid outlet 94 formed at the second end face 88, which is in communication with the tire assembly 24. The fluid inlet 92 and the fluid outlet 94 are both coaxial with the bore 90.

[33] The second end face 88 includes a radially extending flange portion 96 that is mounted to an end face of the wheel hub 50 with a plurality of fasteners 98. The wheel hub 50 is rotatably supported by a pair of wheel bearings 100 for rotation relative to a non-rotating spindle ~~tube~~ 102, which is supported by the gear housing 80.

[34] A tee connection and hose assembly 104 is mounted to the second end face 88 of the wheel shaft 82. The tee connection and hose assembly 104 transfers air from the bore 90 to the tire assembly ~~24~~ 490. In one disclosed embodiment, the tee connection and hose assembly 104 includes a threaded body portion 106 that is received within a threaded portion 108 of the wheel shaft 82. While a threaded attachment is preferred, any other connection and hose assembly known in the art and any known attachment method could be used to form the air connection from the second end face 88 to the tire assembly 24.

[36] When tire pressure falls below a predetermined level, air is supplied from the air supply 14, through the needle portion 124, and into the bore 90. The air then flows from the bore 90, through the tee connection and hose assembly 104, and into the tire assembly 24.

[40] An air supply needle 146, similar to that described above, is mounted to the axle housing 58. The air supply needle 146 includes a threaded base portion 148 that is attached to the axle housing 58 and a hollow needle portion 150 that extends from the base portion 148. The needle portion 150 extends through the central bore 142 and into bore 90. The needle portion 150 pierces or is inserted through a small opening formed within the gland seal 132 such that the gland seal 132 resiliently engages the needle portion 150 to provide a sealed rotary connection. Air flows from the air supply 14, through the hose pressure lines ~~connections~~-20, through the needle portion 150, and into the bore 90.

[42] An air supply needle 174, similar to that described above, is mounted to the axle housing 58. The air supply needle 174 includes a threaded base portion 176 that is attached to the axle housing 58 and a hollow needle portion 178 that extends from the base portion 176. The needle portion 178 extends through the internal bore 170 and into bore 90. The needle portion 178 resiliently engages seals 172 to provide a sealed rotary connection. Air flows from the air supply 14, through the hose pressure lines ~~connections~~-20, through the needle portion 178, and into the bore 90.

[44] While Figures 5-8 show various examples of air supply component assemblies, it should be understood that other air supply component assemblies could also be used to provide a sealed rotary connection between the non-rotating axle housing 58 and the rotating wheel shaft 82. By forming a single bore passage-90 extending through the center of the wheel shaft 82, a simple method of providing a CTIS system 10 for an inverted portal drive axle 12 is achieved. The interface between the bore passage-90 and the air supply 14 can be simply and easily installed in this configuration. Further, the relatively short wheel shaft 82 is used to provide a single, easily sealed bore passage-90 for conventional spindle configurations or unitized wheel bearing configurations. The system 10 is simple to maintain, requiring no removal of the wheel hub 50 to repair or replace any CTI component. Compared to traditional CTI systems, the subject invention utilizes components that are small, simple, and inexpensive.

**IN THE CLAIMS**

1. (Currently Amended) A tire inflation system for a wheel end assembly comprising:  
an input operably coupled to a driving power source;  
an output driven by said input, said output including a wheel shaft coupled to a wheel hub for rotation about a wheel axis wherein said wheel shaft includes a laterally extending bore having a first end in fluid communication with an air source and a second end in fluid communication with a tire assembly mounted for rotation with said wheel hub; and  
a seal assembly cooperating with said first end of said laterally extending bore to provide a sealed air flow path extending from the air source, through said bore, and to the tire assembly.
2. (Original) The system set forth in claim 1 wherein said wheel shaft includes a first end face defining a fluid inlet in communication with the air source and a second end face defining a fluid outlet in communication with the tire assembly, said laterally extending bore extending through the entire length of said wheel shaft from said first end face to said second end face.
3. (Original) The system set forth in claim 2 wherein said laterally extending bore is parallel to said wheel axis.
4. (Original) The system set forth in claim 2 wherein said fluid inlet and said fluid outlet are coaxial with said bore.

5. (Currently Amended) The system set forth in claim 2 including an air supply component having a base member in fluid communication with the air supply and mounted to a non-rotating wheel component and an air conduit extending from said base member, through said seal assembly, and into said laterally extending bore.
6. (Currently Amended) The system set forth in claim 5 wherein said seal assembly includes a resilient gland seal received within said laterally extending bore and mounted for rotation with said wheel shaft, a gland nut attached to said first end face of said wheel shaft and defining an internal nut bore wherein said air conduit extends through said internal nut bore and is engaged by said resilient gland seal to define a seal interface.
7. (Currently Amended) The system set forth in claim 5 wherein said wheel shaft includes a secondary bore at said first end face, said secondary bore having a greater diameter than said laterally extending bore and wherein said seal assembly includes a seal body defining an internal seal bore, at least one internal seal received within said internal seal bore, and at least one external seal surrounding an external surface of said seal body, said seal body being mounted within said secondary bore with said air conduit extending through said internal seal bore to sealingly engage said at least one internal seal.
8. (Currently Amended) The system set forth in claim 7 wherein said seal body includes a channel formed around said external surface to receive said external seal and establish sealing engagement between said seal body and said secondary bore and wherein said at least one

internal seal comprises first and second o-rings mounted within first and second grooves formed within said internal seal bore, said first and second o-rings being positioned on opposite sides of said at least one external seal.

9. (Currently Amended) The system set forth in claim 5 wherein said seal assembly includes a tube mounted at said first end face for rotation with said wheel shaft and at least one resilient seal received within said tube, said air conduit extending through said tube to sealingly engage said at least one resilient seal.

10. (Original) The system set forth in claim 1 wherein said input comprises an axle shaft defining an axle shaft axis of rotation that is parallel to and spaced apart from said wheel axis.

11. (Currently Amended) A tire inflation system for a drive axle comprising:  
 an input coupled to a driving power source that defines ~~and defining~~ a longitudinal axis;  
 first and second wheel shafts driven by said input and defining a wheel axis that is transverse to said longitudinal axis;

first and second wheel hubs driven by said first and second wheel shafts for rotation about said wheel axis, said first and second wheel hubs each adapted to support ~~supporting~~ a tire assembly wherein each of said first and second wheel shafts comprises a cylindrical shaft body having a first end face and a second end face with a fluid passage extending through the length of said cylindrical shaft body from said first end face to said second end face to define a fluid inlet

in fluid communication with an air supply at said first end face and a fluid outlet in fluid communication with the tire assembly at said second end face; and

first and second seal assemblies cooperating with said first end faces of each of said first and second wheel shafts to provide a sealed air flow path extending from the air supply, through said fluid passage, and to the tire assemblies.

12. (Currently Amended) The system of claim 11 wherein each of said first and second wheel shafts includes an air supply component mounted to a non-rotating axle component, said air supply component including a base member in fluid communication with the air supply and an air conduit extending from said base member, through a respective one of said first and second seal assemblies, assembly, and into said fluid passage.

13. (Currently Amended) The system of claim 12 wherein said first and second wheel shafts each include a bore formed at said first end face, said bore being concentric with said fluid passage and having a greater diameter than said fluid passage and wherein said first and second seal assemblies each include a seal support member mounted at least partially within said bore for rotation with a said-respective one of said first and second wheel shafts and at least one resilient seal member cooperating with said seal support member to sealingly engage said air conduit.

14. (Currently Amended) The system of claim 13 wherein said input comprises a first axle shaft operably coupled to drive said first wheel shaft and a second axle shaft operably coupled to

drive said second wheel shaft, said first and said second axle shafts defining an axle shaft axis of rotation that is parallel to and spaced apart from said wheel ~~axis axes~~ with each said fluid passages of said first and second wheel shafts being parallel to said wheel ~~axis~~ axes.

15. (Original) The system of claim 14 wherein said fluid inlet and fluid outlet are coaxial with said fluid passage.

16. (Currently Amended) A tire inflation system for a portal drive axle comprising:

- an input coupled to a driving power source and defining a longitudinal axis;
- a differential driven by said input;
- first and second axle shafts operably coupled to said differential and defining an axle axis that is transverse to said longitudinal axis;
- first and second wheel gear sets driven by said first and second axle shafts;
- first and second wheel shafts driven by said first and second wheel gear sets, said first and second wheel shafts defining a wheel axis that is transverse to said longitudinal axis, and parallel to and spaced apart from said axle axis;
- first and second wheel hubs driven by said first and second wheel shafts for rotation about said wheel axis, said first and second wheel hubs each adapted to support ~~supporting~~ a tire assembly wherein each of said first and second wheel shafts includes an internally formed fluid passage having a fluid inlet in fluid communication with an air supply and a fluid outlet in fluid communication with the tire assembly; and

first and second seal assemblies cooperating with each ~~said~~ fluid inlets of said first and second wheel shafts to provide a sealed air flow path extending from the air supply, through said internally formed fluid passage, and to each ~~the~~ tire assemblyies.

17. (Original) The system of claim 16 wherein said wheel axis is vertically higher relative to ground level than said axle axis.

18. (Original) The system of claim 17 wherein one of said first and second axle shafts is substantially longer than the other of said first and second axle shafts.

19. (Currently Amended) The system of claim 16 wherein said first and second wheel shafts each comprise a cylindrical shaft body having a first end face and a second end face with said internally formed fluid passage extending through the length of said cylindrical shaft body from said first end face to said second end face to define said fluid inlet at ~~each of~~ said first end faces and said fluid outlet at ~~each of~~ said second end faces.

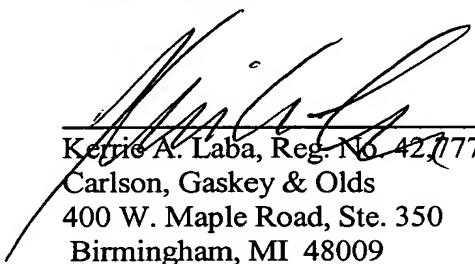
20. (Currently Amended) The system of claim 19 wherein each of said first and second wheel shafts includes an air supply component mounted to a non-rotating axle component, said air supply component including a base member in fluid communication with the air supply and an air conduit extending from said base member, through a respective one of said first and second seal assemblies, and into said internally formed fluid passage.

**REMARKS**

Claims 1-20 remain in the application. The specification and claims have solely been amended to provide consistent terminology. Examination is now requested.

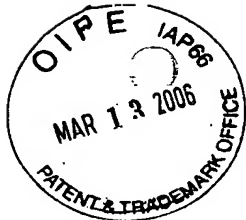
Applicant believes that no additional fees are necessary, however, the Commissioner is authorized to charge Deposit Account No. 50-1482 in the name of Carlson, Gaskey & Olds for any additional fees or credit the account for any overpayment.

Respectfully submitted,



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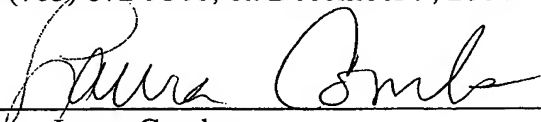
Dated: December 8, 2004



60,130-1907; 03MRA0279

CERTIFICATE OF TRANSMISSION UNDER 37 CFR 1.8

I hereby certify that this correspondence is being facsimile transmitted to the United States patent and Trademark Office, fax number (703) 872-9306, on December 9, 2004.

  
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Laura Combs